Wrist Arthrolysis: A Systematic Review of Open and Arthroscopic Techniques

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Abstract

Background Wrist arthrolysis is a viable option in wrist stiffness and can be performed via open or arthroscopic techniques.

Purpose The aim of the study is to describe and evaluate the available techniques of open and arthroscopic arthrolysis of the radiocarpal joint and the distal radio ulnar joint (DRUJ) in posttraumatic wrist stiffness.

Methods A systematic literature search was performed in PubMed to identify studies reporting on open and arthroscopic wrist arthrolysis. Key words included "open wrist arthrolysis," "arthroscopic wrist arthrolysis," "post-traumatic wrist stiffness," and "DRUJ arthrolysis." Data were extracted independently by a pair of reviewers.

Results Overall, 637 studies were identified; 13 additional articles were found through previous publications (total 650 articles). A total of 612 records resulted after duplicates was removed. Fourteen studies were selected and only eight respected the inclusions criteria. One study focused on volar open arthrolysis and four studies on arthroscopic arthrolysis of the radiocarpal joint; two studies reported on open arthrolysis and two studies on arthroscopic DRUJ arthrolysis. Range of motion following open and arthroscopic wrist arthrolysis improved in all studies.

Conclusion Both arthroscopic and open arthrolysis can lead to similar and satisfactory results in radiocarpal joint and DRUJ stiffness..

Level of Evidence This is a level 3a study.

Keywords
- wrist stiffness
- DRUJ release
- DRUJ stiffness
- arthroscopic wrist arthrolysis
- open wrist arthrolysis

Wrist stiffness can be an important and disabling complication after traumatic injuries or surgical procedures.[1–4] Arthrofibrosis may be stimulated by intra-articular and capsular injuries, as well as prolonged immobilization.[3,4] This could lead to restricted range of motion (ROM), disability, and pain.[3,4] The first treatment should be always a good rehabilitation program of the wrist. In case of lack of improvement, wrist manipulation under general or peripheral anesthesia may be tried, with a potential risk of ligament injuries, bone fractures and avulsions.

Surgical arthrolysis is a viable option that can be performed via open surgery or arthroscopy. Arthrolysis of the radiocarpal joint can be useful in flexion–extension stiffness, while distal radioulnar joint (DRUJ) arthrolysis is indicated in cases with limited pronation–supination. The aim of the present study is to describe and compare the results of open and arthroscopic arthrolysis of the radiocarpal joint and DRUJ in posttraumatic stiffness of the wrist.

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Methods

The systematic review was developed in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement,[5] using the methods described in the Cochrane Handbook for Systematic Reviews of Interventions. A meta-analysis was not possible because some data in the studies was missing and the measurements were not homogeneous.

Data Sources and Searches

An extensive search strategy was designed in collaboration with an independent research librarian to capture all relevant articles relating to wrist arthrolysis. The search strategy was applied to the PubMed-MEDLINE databases until January 15, 2020 with the following keywords: "open wrist arthrolysis," "arthroscopic wrist arthrolysis," "posttraumatic wrist stiffness," "arthroscopic wrist capsular release," and "DRUJ arthrolysis."

Inclusion/Exclusion Criteria

The inclusion and exclusion criteria were defined during the protocol stage. Inclusion criteria included studies with a population treated for stiffness after wrist fractures with either arthroscopic arthrolysis of the radiocarpal joint and DRUJ or open wrist arthrolysis. Included studies were required to report on the follow-up, gender, age of the patients, pre- and postoperative ROMs of the wrist, pain, and had to be published in English or where an English translation had to be available. Case reports and new techniques reports were also included. Studies with cerebral palsy, arthrogryposis, and hemiplegia were excluded. Studies not published on PubMed, literature reviews, letters to editors, book chapters, and presentations to congress were excluded. Details, such as age, gender, surgical procedure, used measurements, length of follow-up, postsurgery complications, and outcomes were collected as basic data. The data were then simplified into ►**Tables 1** and **2**.

Selection of Studies

Studies were independently screened by title and abstract by two authors (M.G. and M.C.). The references of all included studies and all relevant review articles on the topic were also reviewed to identify other potential studies for inclusion. This was followed by a full-text evaluation of the selected studies. A third reviewer (R.L.) was available for any disagreement that could not be resolved by this initial discussion.

Data Extraction

Two reviewers (M.G. and M.C.) independently extracted data. The data included the author name, year of publication, journal, population type and demographics as well as type of measurement used. If data was not available from full-text articles or trial registrations, authors were contacted to provide this information. If authors did not provide the required additional data, then this aspect of the study was excluded from the data synthesis.

Outcomes

Flexion-extension for the radiocarpal arthrolysis and the pronation-supination for the DRUJ arthrolysis were data of primary interest. All possible complications were noted.

Results

637 studies were identified by the search, 13 additional articles were found through previous publications (650 articles). 612 records resulted after duplicates were removed. Following initial screening, 31 studies remained: 14 studies were then identified as eligible for inclusion, but 6 studies were not included due to the lack of some data and for the language (►**Fig. 1**).

Of the eight included studies, three reported on open techniques (one article on open volar wrist capsulotomy, two articles on open DRUJ arthrolysis). Five articles studied the results of the arthroscopic arthrolysis (four on radiocarpal and midcarpal arthrolysis and one on DRUJ arthrolysis). The results are summarized in ►**Tables 1** and **2**.

Radiocarpal Joint

Open Volar Arthrolysis

In 2017, Kamal and Ruch[6] proposed a subperiosteal dissection of the volar capsule and volar extrinsic ligaments by elevating the volar capsule from the distal radius. They released the volar extrinsic wrist ligaments from the volar radial aspect of the distal radius and then performed a section of the radioscaphocapitate ligament (RSC), long radiolunate ligament (LRL), and part of the short radiolunate ligament (SRL). At 2-week postoperatively, patients started a hand therapy program with passive and active motion of the wrist without any restrictions. They added a volar distal radioulnar joint capsule release for lack of supination in two patients. Carpal stability was maintained after release, likely secondary to the presence of other extrinsic ligaments that stabilize the carpus to the distal radius and ulna (the remnant of the SRL, ulnolunate, ulnotriquetral, and dorsal radiocarpal ligaments).

Arthroscopic Arthrolysis

In 2000, Verhellen and Bain[7] reported on an innovative arthroscopic release of the volar capsule in two patients. The section of the volar capsule included the SRL ligament, the radioscapholunate (RSL) ligament, LRL ligament, and RSC ligament. The ulnotriquetral and ulnolunate ligaments were left intact. The authors based their technique on the research of Viegas and colleagues[8] that sectioning of those ligaments did not result in ulnar or palmar translation. When they added the sectioning of the ulnar carpal (UC) ligaments, palmar translation of the carpus occurred. The sectioning of the dorsal ulnar (DUL) and palmar ulnar (PUL) ligaments determined an ulnar translation as well. Verhellen and Bain[7] described the safety of this technique and the improvement of wrist ROM, grip strength, and pain at 6 months after surgery. Hattori et al[9] reported on 11 patients treated arthroscopically with a mean age of 40 years. They also

Table 1 Studies with open arthrolysis

Author	Year	Technique	No. of cases	Age (y)	Sex	Dominant hand	Cause of stiffness	Follow-up (y)	Results (average)	Additional findings
Kamal and Ruch[6]	2017	Open volar capsular release	11	45 (range: 21–62)	6 women and 5 men	Not reported	Wrist stiffness after volar plating for distal radius fracture	4.5	Pre-op and post-op Flexion: 36 and 63 degrees Extension: 25 and 59 degrees Pronation: 61 and 76 degrees Supination: 49 and 72 degrees DASH score: 46 and 10 VAS score: 2.6 and 2.2	In two patients, additional procedures were completed, including volar distal radioulnar joint capsule release for lack of supination. About 50% of the volar capsule was released
Af Ekenstam[12]	1988	Capsulotomy DRUJ	18	44 (range: 17–67)	15 women and 3 men	10 dominant, 8 nondominant	15 patients had previous surgeries (in 5 the radius previously had been osteotomized). In the other 3 cases the TFCC was injured	1 to 6	Preop and postop Forearm rotation: 92 and 138 degrees Supination: 45 and 66 degrees Pronation: 46 and 71 degrees Grip strength: 50 and 70% (injured/uninjured hand)	Fibrotic thickening of the capsule was a common finding in all cases. In one patient the capsulotomy was repeated 8 months after surgery
Kleinman and Graham[13]	1998	Capsulotomy DRUJ–"silhouette" resection	9	40 (range: 25–48)	5 women and 4 men	6 dominant, 3 nondominant	8 of the 9 patients sustained displaced fractures of the distal radius and underwent open reduction and internal fixation	Not reported	Mean ROM improvements Flexion/extension: +20 degrees Supination: + 51 degrees Pronation: +- 28 degrees Grip strength: 55% (injured/uninjured hand)	There were no perioperative or postoperative complications. No patient experienced even transient ulnar neurapraxia

Abbreviations: DASH, disabilities of the arm, shoulder, and hand; DRUJ, distal radio ulnar joint; post-op, postoperative; pre-op, preoperative; ROM, range of motion; VAS, visual analogue scale.

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Table 2 Studies with arthroscopic arthrolysis

Author	Year	Technique	No. of cases	Age (y)	Sex	Dominant hand	Cause of stiffness	Follow-up	Results (average)	Additional findings
Verhellen and Bain[7]	2000	Arthroscopic radio carpal arthrolysis	2	29 (range: 23–35)	1 woman and 1 man	Not reported	Wrist stiffness after volar plating for distal radius fracture	6 months	Pre-op and post-op Flexion: 17.5 and 47.5 degrees Extension: 10 and 50 degrees Grip strength: 13.5 and 52.5 kg VAS score: 1.5 and 1	The dorsal capsule was divided from the sigmoid notch to the radial styloid with the aid of cutting cautery The ulnotriquetral and ulnolunate ligament were left intact
Hattori et al[9]	2006	Arthroscopic radio carpal arthrolysis	11	40 (range: 16–65)	2 women and 9 men	Not reported	Eight fractures of the distal radius (6 intra-articular and 2 extra-articular), 1 Galeazzi's fracture, 1 perilunate dislocation, and 1 carpal bone contusion	13 months (range: 4–24 months)	Pre-op and post-op Extension: 47 and 56 degrees Flexion: 29 and 42 degrees	Three types of radiocarpal septa • Type A septa: a single fibromembranous structure completely divides the radiocarpal joint between the lunate and the scaphoid fossae • Type B septa: membranous structures with a fenestration that partially divides the radiocarpal joint between the lunate and the scaphoid fossae • Type C septa: multiple bands of fibrous tissue are formed between radiocarpal articulations
Luchetti et al[10]	2007	Arthroscopic radio carpal and DRUJ arthrolysis	22	Mean age of 37 year	6 women and 16 men	22 dominant	All patients had wrist stiffness after a long-lasting immobilization for distal radius fracture	28 months (range: 9–144 months)	Preop and postop Flex/extension: 84 and 99 degrees Prono/supination: 144 and 159 degrees Grip strength: 22 and 28 kg VAS pain: 7.7 and 2 Mod Mayo Wrist Score: 28 and 79	Presence of fibrotic bands between the radius and carpal bones (scaphoid or lunate bones, scapholunate ligament) in all cases. In three cases, fibrotic bands were also located in the ulnocarpal joint. Loose bodies were found in nine cases
Bain et al[11]	2008	Arthroscopic radio-carpal arthrolysis	12	Not reported	Not reported	Not reported	Not reported	Not reported	A 75% improvement (degree not available) in range of motion and grip strength was reported by 9 of the 12 patients	Three patients reported having a 25 to 50% improvement with a poor to good result

Table 2 (*Continued*)

Author	Year	Technique	No. of cases	Age (y)	Sex	Dominant hand	Cause of stiffness	Follow-up	Results (average)	Additional findings
Del Piñal et al[14]	2018	Arthroscopic arthrolysis of the DRUJ	6	15–71 years	4 women and 2 men	4 dominant, 2 nondominant	Five of them had sustained a distal radius fracture: 3 had been treated with a volar plate (1 of them for an extra-articular malunion), 1 with an external fixator and Kirschner's-wires, and 1 had been treated in a cast	3.3 years (range: 1–6.4 months)	The mean supination was 76 degrees at the latest follow-up. The total arc of improvement in pronosupination was 97 degrees	No report of postoperative DRUJ instability, ulnar wrist pain, or other complications

Abbreviations: DRUJ, distal radio ulnar joint; post-op, postoperative; pre-op, preoperative; VAS, visual analogue scale.

described a classification of three different types of membranous radiocarpal septa (►**Table 2**).

Luchetti et al[10] described their results for 22 patients treated with arthroscopic wrist arthrolysis. They did not note any complications. Two patients were treated arthroscopically for DRUJ release. Bain et al[11] reported on the results of 12 patients treated with a dorsal arthroscopic capsular release. The structures most at risk are the extensor tendons and those structures surrounding the arthroscopy portals. They used a nylon tape passed through the 3–4 portal to the level of the tendon–capsule interface, then along this plane and out again via the 6R portal. By pulling this tape, they could increase the safe zone for the capsular release without tendon injury.

Distal Radioulnar Joint

Open Arthrolysis

Af Ekenstam[12] in 1988 examined 18 patients with wrist stiffness after distal radius fracture. In case of deficit of pronation, a dorsal capsulotomy was used, while in restricted supination, the authors used a volar approach. In cases of restricted pronation and supination, they combined volar and dorsal approaches.

In 1998, Kleinman and Graham[13] reported their experience in nine patients by describing the so-called "silhouette" capsulectomy of the volar capsule of the DRUJ for the loss of supination and of the dorsal DRUJ capsule for the loss of pronation. They excised the DRUJ capsule from its insertions into the radius, the triangular fibrocartilage complex (TFCC), and ulna. They did not find any complication.

Arthroscopic Arthrolysis

In 2007, Luchetti et al[10] described a method for an arthroscopic release of DRUJ contractures by using DRUJ portals. A dissector was introduced through the proximal portal to release the adhesions between the ulnar head and the sigmoid fossa. They reported an improvement of the pronation–supination. Del Piñal et al[14] published a procedure to correct supination losses of 90 degrees with a curved periosteal elevator through the 6R portal into the volar–radial corner of the TFCC. They advanced it proximally gliding on the anterior ulnar head surface to release the volar capsule and the ulnar head. The authors combined the arthroscopic arthrolysis with a manipulation of the wrist. Full supination was maintained in an orthosis for 2 to 3 days. There were no cases of DRUJ instability or other complications.

Discussion

The origin of posttraumatic wrist joint stiffness can be either extra-articular (capsular contracture, tendons adherences), intra-articular (arthrofibrosis and articular deformity, secondary to articular fractures) or both. The concept of having the capsule as a separate category was at first developed for the shoulder and elbow and then extended to the wrist.[15] The capsule is a special structure that is often injured in the first insult and it is prone to contracture. This can occur especially

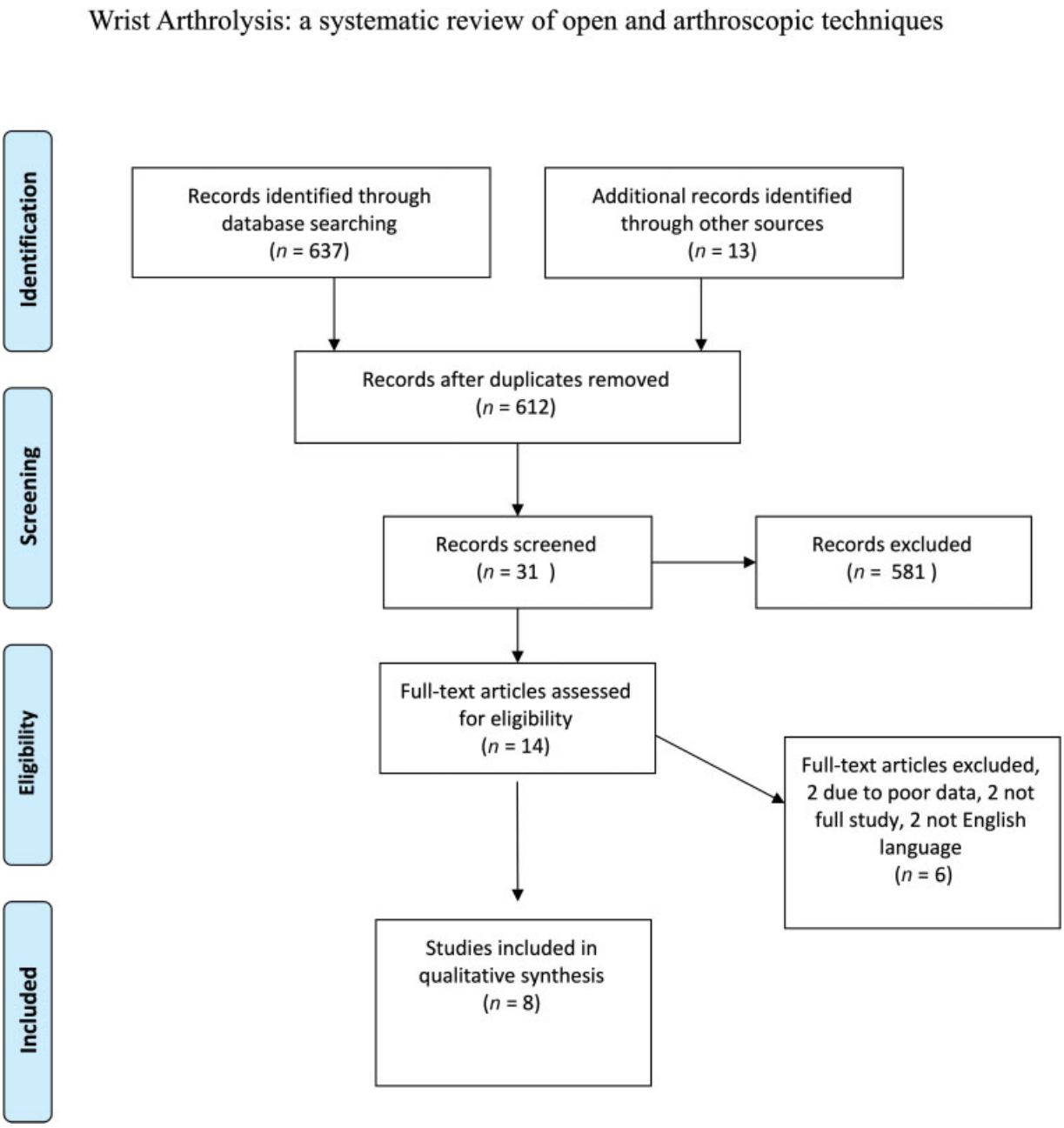

Fig. 1 PRISMA statement of the study. PRISMA, preferred reporting items for systematic reviews and meta-analyses.

when the joint is immobilized with higher risk in patients with a complex regional pain syndrome (CRPS).

Arthrofibrosis is the result of an excessive fibrotic response during the repair process, which leads to fibrotic tissue deposition, within or around the joint. This determines a progressive loss of motion of the joint. The process is started by an excessive synovial inflammatory response with proliferation of fibroblast cells and a significant increase in the deposition of extracellular matrix proteins.[3,4] Wrist arthrolysis results are linked to the preoperative condition of the articular surface of both the radius and carpus. A poor articular surface may be responsible for failure or recurrence of stiffness after arthrolysis and intensive rehabilitation of the wrist.[16]

Wrist contracture rarely involves the midcarpal joint as well. Although arthroscopy starts at the level of the radiocarpal joint, the midcarpal joint should always be thoroughly evaluated.[16,17] However, there are no reports on the midcarpal joint involvement in wrist stiffness. In the examined studies about radiocarpal stiffness, both open and arthroscopic techniques showed improved postoperative wrist ROM (►**Table 3**). The postoperative improvement of the flexion/extension ROM found by Kamal and Ruch[6] with the open technique (+61 degrees) are similar to those published by Verhellen and Bain[7] with the arthroscopic release (+-70 degrees). Lower values were described in the other arthroscopic reports.[9,10] Luchetti et al[10] explained that the discrepancy in results was related to their strict inclusion

Table 3 Average postoperative ROM improvements

Radiocarpal arthrolysis		Flexion/extension post-op improvement (degree)
Open	Kamal and Ruch[6]	+61
Arthroscopic	Verhellen and Bain[7]	+70
	Hattori et al.[9]	+22
	Luchetti et al[10]	+15
	Bain et al[11]	+75% (degree not available)
DRUJ arthrolysis		Pronation/supination post-op improvement
Open	Af Ekenstam[12]	+46
	Kleinman and Graham[13]	+79
Arthroscopic	Luchetti et al[10]	+15
	Del Piñal et al[14]	+97

Abbreviations: DRUJ, distal radio ulnar joint; post-op, postoperative; ROM, range of motion.

criteria and all their patients had greater preoperative wrist ROM compared with the other studies (►**Table 2**). The disabilities of the arm, shoulder, and hand (DASH) score improved consistently in all the studies that have included its measurement.[6,7,10] Kamal and Ruch[6] did not observe a postoperative change of the visual analogue scale (VAS) for pain after open arthrolysis, while in arthroscopic techniques, Luchetti et al[10] reported an improvement from 7.7 to 2.

In losses of ROM in pronation/supination, arthrolysis of the distal radioulnar joint may also be performed. DRUJ stiffness is frequently encountered and it can be isolated or associated with the radiocarpal joint. Previous studies[18] underlined the major role of the volar DRUJ capsule in posttraumatic reduction of supination. This volar portion with its redundant folds is more susceptible to injury and swelling and subsequent reactive fibrosis, explaining why supination loss is more likely than pronation. The studies with open DRUJ arthrolysis[12,13] demonstrated an average improvement in pronation–supination of 62.5 (+46/+79) degrees. The postoperative results of arthroscopic arthrolysis[10,14] showed a mean ROM improvement in pronation–supination of 56 (+15/+97) degrees. The lower improvement (+15 degrees) reported by Luchetti et al[10] is to be referred to less severe preoperative wrist stiffness. Del Piñal et al[14] achieved a full supination in all patients intraoperatively, but at the latest follow-up, the mean supination was 76 degrees and the mean improvement in supination was 80 degrees. With open DRUJ capsulotomy techniques, the grip strength raised to 55%[13] and to 70%[12] of the contralateral side. Luchetti et al[10] reported an average raise in the postoperative grip strength from 22 to 28 kg.[10] Arthroscopy of the DRUJ is demanding, especially in posttraumatic cases where it can be very hard to have good intra-articular visibility due to capsular contraction and intra-articular fibrosis that lead to an almost closed joint. Conversion to open surgery is always possible when difficulty is encountered during the arthroscopy.[16,17] An important feature is the different invasiveness of these techniques. In open arthrolysis, the joint is opened from the outside (capsular resection) followed by the internal fibrosis resection. The arthroscopic arthrolysis however permits to release the internal fibrosis first, followed by a capsular resection if needed. During the arthroscopic arthrolysis, the wrist motion is constantly evaluated and the capsular resection can be interrupted as soon as the mobility of the wrist is considered acceptable.

Limitations and Conclusion

One of the potential drawbacks of open surgery is a greater tissue damage that could generate adherences, pain, edema, and a recurrent stiffness. Another issue after an extensive open capsular release is to develop a potential joint instability that may require secondary stabilization. Arthroscopy instead may discover associated lesions such as loose bodies, osteochondritis, partial, or complete tears of the intercarpal ligaments and TFCC, and articular incongruity (step-off) may not have been evident on preoperative investigations[16,17]

Due to the lack of data in some studies, it was not possible to perform a complete meta-analysis and the results reported do not clearly show a superiority of one technique over the other. One of the limitations of this systematic review is the nonhomogeneity of the studies regarding the sample (gender, age, and follow-up) and for the preoperative diagnosis. Another weakness might be a bias during article selection. Incomplete information from the article title and abstract might infer different meanings of the real condition of the patients than can be clearly shown in full-text articles. Additionally, only a single database was used to find the relevant articles. Any studies that were not indexed by the database could have been missed.

Authors' Contributions
M.G., I.B., and E.R. researched literature and conceived the study. M.G., R.L., and M.C. were involved in protocol development data analysis. M.G. wrote the draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

Ethical Approval
Ethical approval was not sought for this article because not needed for our Ethical committee. Informed consent was not sought for this article because it is a systematic review.

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Conflict of Interest
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